

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0407 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 08/07/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: 17" DISC VALVE ASSY, ORB LH2 BOEING	MC284-0389-1461
LRU	: 17" DISC VALVE ASSY, ET LH2 BOEING	MC284-0389-0602

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

DISCONNECT, LH2 FEED (WITH LATCH) 17 INCH, ORBITER & ET HALF.

VALVE WAS ORIGINALLY DESIGNED AND MANUFACTURED BY PARKER-HANNIFIN. BOEING IS A CERTIFIED ALTERNATE PRODUCTION AGENCY.

REFERENCE DESIGNATORS: PD2

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

ET/ORBITER FEED LINE DISCONNECT PROVIDES LH2 PROPELLANT TO THE MPS AND A MEANS OF LOADING AND DETANKING THE ET. EACH DISCONNECT HALF CONTAINS A PNEUMATICALLY ACTUATED FLAPPER CLOSURE DEVICE WHICH REMAINS IN ITS LAST ACTUATED POSITION (BISTABLE). THE VALVES ARE CLOSED AFTER MECO TO PREVENT PROPULSIVE VENTING LEADING TO ET/ORBITER RECONTACT, TILE/DOOR DAMAGE DUE TO EXPOSURE TO PROPELLANTS, LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESSURIZATION, AND SYSTEM CONTAMINATION DURING ENTRY. DURING UMBILICAL SEPARATION, THE VALVE SYSTEM IS DESIGNED TO MECHANICALLY CLOSE BOTH THE ORBITER AND ET DISCONNECT FLAPPERS IF UNABLE TO CLOSE THEM PNEUMATICALLY (POST MECO). REDUNDANT OPEN AND CLOSE (TWO EACH) VALVE POSITION SWITCHES ARE LOCATED ON THE ORBITER HALF OF THE DISCONNECT. THE FLAPPER DRIVE MECHANISM IS DESIGNED TO ALLOW RELIEF OF PROPELLANTS TRAPPED BETWEEN THE FLAPPERS AFTER DISCONNECT CLOSURE.

A PNEUMATICALLY ACTUATED LATCH MECHANISM IS PROVIDED TO PREVENT THE VALVE FLAPPERS FROM CLOSING DURING FLOW CONDITIONS. THE LATCH IS BISTABLE AND IS CONTROLLED BY A SEPARATE PNEUMATIC ACTUATOR ASSEMBLY WITH REDUNDANT

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LOCK AND UPLOCK (TWO EACH) POSITION SWITCHES. LATCH MECHANISM INCORPORATES TOGGLE PIVOT WHICH ALLOWS FLAPPER CLOSURE DURING BACK UP MECHANICAL SEPARATION WITH LATCH IN LOCKED POSITION. SEE LATCH FMEA/CIL 03-1-0454 FOR ADDITIONAL INFORMATION.

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LRU: 17" LH2 FEEDLINE DISC ORB/ET (PD2)

ITEM NAME: 17" LH2 FEEDLINE DISC ORB/ET (PD2)

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

DISCONNECT FLAPPER(S) FAIL TO CLOSE

MISSION PHASE:

PL PRE-LAUNCH

LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA

103 DISCOVERY

104 ATLANTIS

105 ENDEAVOUR

CAUSE:

CONTAMINATION, PIECE PART STRUCTURAL FAILURE, BINDING

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) N/A

B) N/A

C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

CASE 1 - ORBITER FLAPPER:

CONTAMINATION OR STRUCTURAL FAILURE OF THE MECHANICAL LINKAGE TO THE ORBITER FLAPPER WOULD NOT ALLOW THE FLAPPER TO CLOSE EITHER BY PNEUMATIC ACTUATION OR BY MECHANICAL SEPARATION CLOSURE (UMBILICAL RETRACT). VEHICLE SOFTWARE WILL INHIBIT ET STRUCTURAL SEPARATION SINCE BOTH DISCONNECT CLOSED SWITCHES WILL PROPERLY INDICATE ORBITER FLAPPER FAILURE TO CLOSE.

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CASE 2 - ET FLAPPER

CONTAMINATION OR BINDING IN THE DRIVE MECHANISM LINKAGE WILL NOT ALLOW ET FLAPPERS TO CLOSE. BINDING IN THE DRIVE MECHANISM LINKAGE WILL RESULT IN POSSIBLE FAILURE TO CLOSE BOTH FLAPPERS DURING BACKUP MODE UMBILICAL SEPARATION. THIS IS DUE TO MECHANICAL INTERFERENCE BETWEEN ORBITER FLAPPER FORK AND ET ROLLER ARM ASSEMBLY.

CASE 3 - ET AND ORBITER FLAPPERS:

BINDING IN THE DRIVE MECHANISM LINKAGE AT THE INPUT END OF THE ET FLAPPER TORSION BAR OR INPUT END OF THE ORBITER FLAPPER DRIVE SHAFT WILL RESULT IN POSSIBLE FAILURE TO CLOSE BOTH FLAPPERS EITHER BY PNEUMATIC ACTUATION OR BY MECHANICAL SEPARATION CLOSURE (UMBILICAL RETRACT). THIS IS DUE TO MECHANICAL INTERFERENCE BETWEEN FLAPPER FORK AND ROLLER ARM ASSEMBLY.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

CASE 1:

FOR NOMINAL, ATO, AND AOA MISSIONS ET SEPARATION IS DELAYED FOR SIX MINUTES TO VENT RESIDUAL PROPELLANT THROUGH FAILED DISCONNECT. THIS IS TO PREVENT ORB/ET RECONTACT DUE TO PROPULSIVE VENTING AT SEPARATION. POSSIBLE TILE AND DOOR DAMAGE AT THE ORB/ET UMBILICAL AREA DUE TO CRYO EXPOSURE. FOR RTLS, TAL, AND MISSIONS WHERE OMS BURN CANNOT BE DELAYED ET STRUCTURAL SEPARATION IS NOT DELAYED AND ET/ORB RECONTACT IS LIKELY. ALSO RESULTS IN LOSS OF HELIUM SUPPLY DURING MANIFOLD REPRESS CAUSING POSSIBLE LOSS OF AFT COMPARTMENT ENTRY PURGE.

CASE 2:

FOR BINDING, RESULTS IN FAILURE TO SEPARATE ET FROM ORBITER. FOR CONTAMINATION, RESULTS IN ET FLAPPER FAILING TO CLOSE WHICH MAY CAUSE POSSIBLE TILE AND DOOR DAMAGE AT THE ORB/ET UMBILICAL AREA DUE TO CRYO EXPOSURE.

CASE 3:

MAY RESULT IN FAILURE TO SEPARATE ET FROM ORBITER.

(D) CREW, VEHICLE, AND ELEMENT(S):

POSSIBLE LOSS OF CREW/VEHICLE.

(E) FUNCTIONAL CRITICALITY EFFECTS:

1R2 2 SUCCESS PATHS. TIME FRAME - LOADING/PRELAUNCH

- 1) EXTERNAL LEAKAGE AND FIRE REQUIRING ISOLATION OF THE EXTERNAL TANK.
- 2) 17" DISCONNECT FAILS TO CLOSE WHEN COMMANDED BY GROUND.

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RESULTS IN FAILURE TO ISOLATE THE EXTERNAL TANK AND PROPELLANTS FROM FIRE.
POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:

A PNEUMATIC ACTUATOR MOUNTED ON THE ORBITER HALF OF THE DISCONNECT DRIVES THE ET FLAPPER THROUGH A ROLLER/CLEVIS LINKAGE. THIS ACTION IN TURN DRIVES A SECOND ROLLER/CLEVIS LINKAGE WHICH OPERATES THE ORBITER FLAPPER AND THE POSITION INDICATOR ASSEMBLY.

DESIGN FACTORS OF SAFETY FOR INTERNAL PRESSURE ARE 1.3 PROOF, 1.5 BURST FOR THE DISCONNECT. THE ORBITER FLAPPERS HAVE A MINIMUM USEFUL LIFE OF 3500 CYCLES WHICH IS EQUIVALENT TO 100 ORBITER MISSIONS. THE ET FLAPPERS HAVE A MINIMUM LIFE OF 150 CYCLES WHICH IS EQUIVALENT TO ONE ORBITER MISSION. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGINS OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATION; FRACTURE/FATIGUE ANALYSIS SHOW THAT ALL CRITICAL PARTS ARE SATISFACTORY FOR FOUR TIMES EXPECTED LIFE (ET - ONE MISSION, ORBITER - 100 MISSIONS).

THE DISCONNECT VALVE CONSISTS OF COMPONENTS MANUFACTURED FROM 2024-T651 AL ALLOY (FLAPPER ASSEMBLY), INCONEL 718 (ARM FOLLOWER) AND A286 CRES (ARM DRIVE ASSEMBLY). THE VALVE HOUSING IS MANUFACTURED FROM 2219 AL ALLOY. THE ROLLER, FORK, TORSION BAR AND DRIVE SHAFT ASSEMBLIES ARE MANUFACTURED FROM INCONEL 718 AND CRES MATERIALS. BINDING IS PRECLUDED BY USE OF VESPEL BUSHING/BEARINGS.

THE PNEUMATIC ACTUATOR (PRIMARY MODE) OPERATES THE DISCONNECT FLAPPERS OPEN-TO-CLOSE AND CLOSE-TO-OPEN WITH AN EXTERNAL HELIUM SOURCE GAS PRESSURE OF 740 PSIG. THE PNEUMATIC ACTUATOR PISTON SEALS ARE REDUNDANT TO MINIMIZE LEAKAGE. DYNAMIC SEAL IS OF RULON "A", SPRING IS OF 310 OR 302 CRES. STATIC SEAL IS OF TFE TEFLON, SPRING IS OF 301 CRES. DESIGN FACTORS OF SAFETY FOR INTERNAL PRESSURE ARE 1.5 (PROOF), AND 2.0 (BURST) FOR THE ACTUATOR. PROOF PRESSURE TESTED TO 1275 PSIG. ACTUATOR PISTON (6061-T651 AL) SLIDES IN CYLINDER ASSEMBLY (SURFACE FINISH IS 8 MICROINCH) ON NONMETALLIC PISTON GUIDES (SURFACE FINISH IS 32 MICROINCH). ROD (304 CRES, SURFACE FINISH 8 MICROINCH) SLIDES ON NONMETALLIC BEARINGS (SURFACE FINISH 32 MICROINCH).

THE DISCONNECT IS ALSO DESIGNED TO ALLOW MECHANICAL CLOSURE OF FLAPPERS AS A BACKUP MODE UPON DISENGAGEMENT OF THE ORBITER AND EXTERNAL TANK UMBILICAL ASSEMBLIES. THE MATING SURFACES OF THE EXTERNAL DRIVE MECHANISMS ARE COATED WITH MICROSEAL TO MINIMIZE BINDING.

(B) TEST:

ATP (ACTUATOR)

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PROOF: AMBIENT, 1275 PSIG

OPERATIONAL (TWO CYCLES): AMBIENT; 400, 740, 780 PSIG

RESPONSE TIME (OPENING/CLOSING): ROOM AMBIENT/-300 DEG F
RESPONSE TIME AT 400, 700 AND 780 PSIG

LEAKAGE: EXTERNAL AND INTERNAL, AMBIENT AND CRYO

ATP - ET/ORBITER MATED DISCONNECT ASSEMBLY

FLAPPER ANGLE: ET 0.75 +/- 0.25 DEG, ORB 2.4 +/- 0.25 DEG

TIP LOAD: ET 55 LBF MINIMUM, ORB 40 LBF MINIMUM

POSITION SWITCH VERIFICATION: LATCH IN LOCKED POSITION. ROTATION FROM FLAPPER POSITION OF REST ON DOWNSTRIKE SURFACE TO FLAPPER POSITION WHERE OPEN INDICATOR LIGHT TURNS ON MUST BE 4 DEG, MINIMUM.

PROOF: AMBIENT, 1275 PSIG, ACTUATOR
286 PSIG FOR ORBITER CLOSURE DEVICE
58 PSIG FOR ET CLOSURE DEVICE

OPERATIONAL CYCLE: CRYO, -300 DEG F, ACTUATOR PRESSURE 740 PSIG FOR 8 CYCLES AND 450 PSIG FOR 5 CYCLES
AMBIENT, HE AT 400 PSIG (1 CYCLE) AND 740 PSIG (5 CYCLES)

OPERATING TORQUE: ET LH2 SECTION, -410 DEG F FOR 3.5 HOURS MINIMUM, 150 FT-LBF MAX

CLEANLINESS VERIFICATION: MOISTURE FREE AND CLEANED TO LEVEL 400A OF MA 0110-301

LEAKAGE: EXTERNAL

VALVE: LN2/AMBIENT TEMPS: 50 SCIM OF GHE AT 10 PSIG, 50 SCIM OF GHE AT 50 PSIG; LATCH SHAFT SEAL, 80 SCIM OF GHE LH2 TEMPS: 200 SCIM OF GH2 AT 50 PSIG; LATCH SHAFT SEAL 80 SCIM OF GH2

VALVE ACTUATOR:
CRYO (BODY TEMP AT -300 DEG F, ACTUATOR AT -200 TO 0 DEG F) /AMBIENT TEMPS; 100 SCIM OF GHE AT 740 PSIG

INTERNAL

VALVE: AMBIENT TEMPS: 1000 TO 2500 SCIM OF GHE AT 1 TO 60 PSIG
LN2 TEMPS: 2500 SCIM OF GHE AT 60 PSIG

VALVE ACTUATOR:
CRYO (BODY TEMP AT -300 DEG F, ACTUATOR AT -200 TO 0 DEG F) /AMBIENT TEMPS: 100 SCIM OF GHE AT 740 PSIG

RELIEF OPERATION: -300 DEG F, CRACKING/RESEAT PRESSURE, 0.1-5 PSID (ET ONLY)

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ELECTRICAL CHARACTERISTICS (INSULATION RESISTANCE AND VOLTAGE DROP), AND DIELECTRIC STRENGTH

FLOW LINER - ROUNDNESS VERIFICATION (FREE END EIGHT POINTS MEASUREMENT)

OPERATING TORQUE: ET LH2 SECTION SHALL BE MANUALLY ACTUATED (OPEN/CLOSED) AFTER BEING STABILIZED AT -410 DEG F. TORQUE SHALL NOT EXCEED 150 FT-LBF.

CERTIFICATION

COMPONENT QUALIFICATION (INCLUDES TESTING FROM PREVIOUS CONFIGURATION WITHOUT LATCH)

SALT FOG

VIBRATION - THREE AXES:

SINUSOIDAL: 5 TO 35 HZ AT 0.25 G, ZERO TO PEAK

RANDOM: 20 TO 2,000 HZ 5.7 G RMS FOR X-AXIS, 5.2 G RMS FOR Y AND Z-AXIS, NO FLOW (LN2), FLAPPERS OPEN, LATCH ENGAGED

THE DISCONNECT IS CHILLED WITH LN2 AND STABILIZED AT -300 DEG F. 10 PSIG DISCONNECT, 740 PSIG ACTUATOR. THESE CONDITIONS ARE MAINTAINED THROUGHOUT SINUSOIDAL AND RANDOM VIBRATION. ACTUATOR VENTED DURING LAST TWO MINUTES OF VIBRATION.

THERMAL CYCLE: -400 TO 150 DEG F, 3 CYCLES

OPERATING LIFE: AMBIENT, 740 PSIG HE FOR A TOTAL OF 2,400 CYCLES FOR ORBITER AND 100 CYCLES FOR ET. THE RELIEF MECHANISM WAS CYCLED DURING ET VALVE CYCLING.

CRYO, 740 PSIG HE, -400 DEG F FOR A TOTAL OF 1000CYCLES FOR ORBITER AND 50 CYCLES FOR THE ET. THE RELIEF MECHANISM WAS CYCLED DURING ET VALVE CYCLING.

ELECTRICAL CHARACTERISTICS (INSULATION RESISTANCE AND VOLTAGE DROP)

LEAKAGE: EXTERNAL AND INTERNAL, AMBIENT AND CRYO

ENGAGE - DISENGAGE: ENGAGE FORCE = 1000 LBF MAX,
DISENGAGE FORCE = 6000 LBF MAX

BURST TEST: PNEUMATIC ACTUATOR, 1700 PSIG HYDROSTATIC PRESSURE FOR 2 MINUTES

TYPE I AND TYPE II MATED (OPEN POSITION) 450 PSIG HYDROSTATIC PRESSURE FOR 2 MINUTES

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TYPE I AND TYPE II DEMATED (CLOSED POSITION) 330 PSID TO TYPE I, 68 PSID TO TYPE II FOR 2 MINUTES

UMBILICAL SEPARATION TEST: (WITHOUT LATCH)

THE DISCONNECT WAS INSTALLED IN THE UMBILICAL ASSEMBLY DURING THE SEPARATION TEST PROGRAM. THE UMBILICAL ASSEMBLY WAS SUBJECTED TO RANDOM VIBRATION TESTS (4.4 HOURS PER AXIS) WHILE FILLED WITH LN2. THE DISCONNECT WAS ALSO SUBJECTED TO UMBILICAL RETRACT TESTS AT BOTH NOMINAL CONDITIONS AND SIMULATED HYDRAULIC RETRACT ACTUATOR FAILURES.

UMBILICAL SEPARATION TEST: (WITH LATCH)

FLAPPER PNEUMATICS/LATCH PNEUMATICS/PYROS/RETRACTOR HYDRAULICS

- (1) PNEUMATIC CLOSURE (NORMAL) - 4 CYCLES
- (2) MECHANICAL CLOSURE (BACKUP) - 5 CYCLES

BOTH PERFORMED AT AMBIENT, LN2 AND LH2 CONDITIONS.

FLOW LINER WATER FLOW TESTS: (LH2 VALVE QUALIFIED BY SIMILARITY TO LO2)

DESIGN FLOW TO 13,100 GPM
ALLOWABLE DELTA P IS 10 PSID AT THE LINER

TO DETERMINE THE STABILITY OF THE FLOW LINER. THE FLOW TUBE HAD NO PERMANENT DAMAGE AFTER BEING SUBJECTED TO WATER FLOWS UP TO 20,000 GPM (TEST TIME OF 2 MINUTES / 6 RUNS MINIMUM). AFTER VERIFYING PERFORMANCE AT 20,000 GPM, THE UNIT WAS SUBJECTED TO 22,700 GPM TO VERIFY DESIGN MARGIN (NO PERMANENT DAMAGE).

FLAPPER ANGLE STABILITY MARGIN WATER FLOW TESTS:

ELEVEN (11) EXPLORATORY TEST SERIES (FLOW 4,000 TO 14,200 GPM)
E.T. FLAPPER SETTING VARYING FROM -3.9 TO 2.5 DEG.
ORB. FLAPPER SETTING VARYING FROM -0.9 TO 4.6 DEG.

CERTIFICATION TEST RUN AT WORST CASE PRODUCTION SETTING (FLOW RANGE TO 109% POWER LEVEL).

PRODUCTION ANGLE SETTINGS
E.T. 0.75 +/- 0.25 DEG
ORB. 2.4 +/- 0.25 DEG

FLAPPER TIP LOAD MARGIN WATER FLOW TEST:

SEVEN (7) EXPLORATORY TEST SERIES (FLOW RANGE TO 109% POWER LEVEL)

FLOW 4,000 TO 13,100 GPM
ORBITER: 2.4 +/- 0.1 DEG
TIP LOAD RANGE: 22 TO 60 LBF

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ET: 0.75 +/- 0.1 DEG
TIP LOAD RANGE: 20 TO 61 LBF

RECOMMENDED TIP LOAD:

ORBITER: 40 LBF MINIMUM
ET: 55 LBF MINIMUM

LATCH WATER FLOW TESTS:

ELEVEN (11) EXPLORATORY TEST SERIES (FLOW 4,000 TO 14,800 GPM)

CERTIFICATION TEST RUN AT NOMINAL PRODUCTION SETTING (FLOW RANGE TO 109% POWER LEVEL).

TWO PROOF TESTS: 15,650 GPM AND 15,850 GPM

FILL FLOW DIRECTION: SIMILARITY TO LO2 FILL FLOW TEST

LATCH CRYO FLOW TESTS: (LH2 VALVE QUALIFIED BY SIMILARITY TO LO2)

SIXTEEN (16) TESTS WITH LN2/LO2 (FLOWS VARY FROM ONE ENGINE AT 65% TO THREE AT 109%).

GROUND TURNAROUND TEST

ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. ALL MACHINED ITEMS ARE DIMENSIONALLY INSPECTED AND VERIFIED (MIL-STD-105). CHEMICAL/MECHANICAL PROPERTIES AND RECORDS OF RECEIVED MATERIALS ARE RETAINED FOR VERIFICATION. BODY FORGING IS ULTRASONICALLY AND DYE PENETRANT INSPECTED.

CONTAMINATION CONTROL

CLEANLINESS LEVEL TO 400A VIA FREON FLUSH AND SAMPLE VERIFIED. ALL SEAL GROOVES ARE INSPECTED FOR CLEANLINESS AND EVIDENCE OF DAMAGE.

ASSEMBLY/INSTALLATION

THREADED INSERTS AND CRITICAL DIMENSIONS VERIFIED BY INSPECTION. SEALING SURFACES ARE VISUALLY INSPECTED FOR DEFECTS. REPAIRED AND REWORKED ITEMS ARE DIMENSIONALLY CHECKED. LOG OF CLEAN ROOM VERIFIED. ALL ENGINEERING-DEFINED FEATURES AND SURFACE FINISHES AND TORQUE REQUIREMENTS ARE COMPLETELY INSPECTED AND VERIFIED.

THE PRIMARY INTERFACE SEAL IS CHECKED FOR ID, OD AND ROUNDNESS. ALL DIMENSIONS DEFINED IN DRAWING ARE VERIFIED BY INSPECTION.

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CRITICAL PROCESSES

HEAT TREATMENT AND PART PASSIVATION ARE VERIFIED BY INSPECTION.

NON-DESTRUCTIVE EVALUATION

PARTS ARE RADIOGRAPHICALLY AND DYE PENETRANT INSPECTED AS IMPOSED BY ENGINEERING IN THE DRAWING REQUIREMENTS.

TESTING

ATP AND TEST MEASUREMENT EQUIPMENT CALIBRATION VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

A FAILURE TO CLOSE WAS EXPERIENCED DURING ATP (REFERENCE CAR A7682). THE ACTUATOR PISTON ROD WAS BENT. REVISION "D" WAS MADE TO THE DRAWING AND THIS INCREASED THE REQUIREMENT OF MINIMUM YIELD STRENGTH FROM 36,000 TO 67,000 PSI.

THE 17 INCH DISCONNECT FAILED TO FULLY CLOSE DURING UMBILICAL QUALIFICATION SEPARATION TESTING (REFERENCE CAR AB6240). A REDESIGN OF THE CLEVIS WAS INCORPORATED TO INCREASE THE DRIVESHAFT ROTATION FOR CLOSING THE FLAPPERS.

HIGH CLOSING TORQUE ON THREE OCCASIONS DURING ATP HAS DETERMINED THAT A REDESIGN WAS NECESSARY ON DRIVE SHAFT BEARINGS (REFERENCE CAR'S AB8568, AB8514, AB8726). TOLERANCES ON THE BEARING WERE REVISED AND THE ALLOWABLE TORQUE AT CRYOGENIC TEMPERATURE WAS INCREASED FROM 100 FT-LBS TO 140 FT-LBF.

AN LO2 17 INCH DISCONNECT FAILED TO CLOSE DURING QUALIFICATION TESTING AT CRYOGENIC TEMPERATURES (REFERENCE CAR AB4717). FAILURE TO CLOSE WAS CAUSED BY SOME INSULATING FOAM ON THE ROLLER BLOCK BEARINGS AND INADEQUATE SIDE CLEARANCES IN THE BEARING ASSEMBLY. TEFLON TAPE WILL BE PROVIDED DURING FOAMING OPERATIONS TO EXCLUDE FOAM FROM BEARING AREAS. ALL VEHICLES WERE RETROFITTED WITH REDESIGNED ACTUATORS WHICH PROVIDE ADEQUATE CLEARANCES.

THE LO2 UNIT ALSO FAILED TO CLOSE DURING QUALIFICATION TESTING (REFERENCE CAR AB4077). BEARING MATERIALS WERE CHANGED TO VESPEL SP-1 FROM VESPEL SP-21 WHICH REDUCES THE COEFFICIENT OF FRICTION AND IMPROVES THE BEARING STRENGTH AT CRYOGENIC TEMPERATURES.

A FLOW LINER WAS FOUND DISTORTED UPON REMOVAL FROM NSTL. DAMAGE WAS ATTRIBUTED TO INCORRECT MATING PROCEDURE (REFERENCE CAR AB8941).

A DEVELOPMENT TEST WITH THE FLOW LINER MOUNTED IN THE ET EXPERIENCED A FAILURE WHEN THE FLOW RATE REACHED 30,000 GPM. THE FLOW FORCE ON THE DISTORTED LINER CAUSED THE ORBITER FLAPPER HINGE TO SHEAR (REFERENCE CAR AC5377). THE FAILURE WAS ATTRIBUTED TO EXCESSIVE FLOW DURING FILL AND RUN CONDITIONS.

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THE LO2 FLOW LINER ON OV102 (FLT STS-4) WAS FOUND TO BE DISTORTED DURING POST-FLIGHT CHECKOUT (REFERENCE CAR 04F001). DAMAGE WAS ATTRIBUTED TO AN INCORRECT MATING PROCEDURE OR INTERFERENCE WITH FERRY PLATES.

A ONE-TIME OCCURRENCE DURING LO2 SEPARATION TESTING INDICATED THAT MANUALLY MOVING THE VALVE ACTUATOR ROLLER BLOCK ASSEMBLY COULD CAUSE THE LINKAGE TO TRAVEL OVERCENTER AND LOCK UP. TRIMMING/MACHINING OF THE ACTUATOR PISTON BUMPER SEALS PER NEW DESIGN 5791009-101 PREVENTS THAT PROBLEM FROM REOCCURRING (REFERENCE CAR AC4101).

A FAILURE TO CLOSE DURING ATP OF THE UNIT INITIATED A REDESIGN WHEREBY THE SEALS WERE RELOCATED TO THE PISTON RATHER THAN THE CYLINDER WALL (REFERENCE CAR AB1173).

AN INCIDENT OCCURRED AT KSC WHEN TIP LOAD/ANGLE MEASUREMENT/SETTING TESTS WERE BEING CONDUCTED. ONE OF FOUR FLAPPER OPEN STOP ASSEMBLY SCREWS WAS FOUND TO BE LOOSE. THE PROPER METHOD OF RELATING RUNNING TORQUE TO LOCKING TORQUE WAS NOT PERFORMED. PARKER HANNIFIN DOCUMENT 2EPS5790015 HAS BEEN REVISED TO CORRECT THIS SITUATION (REFERENCE CAR AC7672).

ACTUATOR BEARINGS FAILED DURING THE AMBIENT LIFE CYCLES OF THE QUALIFICATION TEST (REFERENCE CAR AB3744). A REDESIGN WAS IMPLEMENTED WITH VESPEL SP-1 FOR IMPROVED STRENGTH AND REDUCTION OF COEFFICIENT OF FRICTION.

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

FOR NOMINAL, ATO AND AOA MISSIONS, ET SEPARATION WILL BE MANUALLY PERFORMED 6 MINUTES AFTER MECO. THE MPS DUMP IS PERFORMED DURING THIS WAIT PERIOD. DUE TO THE TIME CRITICAL NATURE OF RTLS AND TAL, SEPARATION IS PERFORMED IMMEDIATELY.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	: /S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	: /S/ P. A. STENGER-NGUYEN
DESIGN ENGINEERING	: KOUROSH ANVARI	: /S/ KOUROSH ANVARI
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: BILL LANE	: /S/ BILL LANE
USA SAM	: MIKE SNYDER	: /S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	: /S/ ERICH BASS